

49. The Oligochaeta of the Oxford University Spitsbergen Expedition. By J. STEPHENSON, M.B., D.Sc., Lecturer in Zoology, Edinburgh University.

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(Text-figures 1-6.)

(Results of the Oxford University Expedition to Spitsbergen, No. 20.)

CONTENTS.

	Page
Introduction	1109
Zoozoographical Relations.....	1111
On the "Peptonephridia" of the Enchytræidæ	1113
The Genus <i>Henlea</i>	1116
On the Relations of the Genera <i>Lumbricillus</i> and <i>Enchytræus</i>	1118
Periods of Sexual Maturity	1118
Parasitization	1119
Systematic	1119
Fam. NAIDIDÆ	1119
Genus <i>Nais</i>	1119
<i>Nais josinæ</i> Vejd.	1119
Fam. ENCHYTRÆIDÆ	1119
Genus <i>Henlea</i>	1119
<i>Henlea</i> (<i>Henleanella</i>) <i>heleotrophus</i> , sp. n.	1119
<i>Henlea</i> (<i>Henlea</i>) <i>brucei</i> , sp. n.	1121
<i>Henlea</i> (<i>Henleanella</i>) sp. (1)	1125
<i>Henlea</i> (<i>Hepatogaster</i>) sp. (2).....	1126
Genus <i>Lumbricillus</i>	1126
<i>Lumbricillus ægialites</i> , sp. n.	1126
<i>Lumbricillus necrophagus</i> , sp. n.....	1130
Genus <i>Enchytræus</i>	1133
<i>Enchytræus albidus</i> Henle	1133
<i>Enchytræus crymodes</i> , sp. n.....	1133
<i>Enchytræus</i> sp.	1135
Genus <i>Mesenchytræus</i>	1136
<i>Mesenchytræus</i> sp.	1136
References to Literature	1137

INTRODUCTION.

The Oligochaeta obtained by the Oxford University Spitsbergen Expedition were contained in fifteen tubes—four from Bear Island and the remainder from Spitsbergen. The specimens from Bear Island belonged to two species—*Enchytræus albidus* Henle and *Nais josinæ* Vejd.,—both well known. Of those from Spitsbergen, a number were sexually immature and therefore indeterminable (*Mesenchytræus* sp., two species of *Henlea*, *Enchytræus* sp.); the remainder, most of which occur in more than one of the tubes, comprise two species of *Henlea*, one of *Enchytræus*, and two of *Lumbricillus*, all apparently new. With the exception of the *Nais* from Bear Island, all the worms thus belong to the family Enchytræidæ.

Our previous knowledge of the Oligochæta of Spitsbergen and Bear Island is due almost entirely to Ude (17), who, in addition to collections from Bear Island (then examined for the first time), had also at his disposal a small collection from Spitsbergen, sent to him by Michaelsen and tentatively named, the names having already been entered in the 'Tierreich' volume on Oligochæta (11).

The following species are all that have been recorded:—

From Spitsbergen:—

Lumbricillus pagenstechevi (Ratz.) (originally determined and entered in the Tierreich volume as *L. nervosus* (Eisen)).

Fridericia leydigi (Vejd.).

Mesenchytræus sp. indeterminate.

From Bear Island:—

Marionina ebudensis (Clap.).

Lumbricillus fossarum (Tauber).

Lumbricillus henkingi Ude.

Enchytræus albidus Henle.

The only one of these collected by the Oxford Expedition is *Enchytræus albidus*. All, as will be seen, belong to the Enchytræidæ.

The Enchytræidæ have always furnished the great majority of Oligochæta from high latitudes, and there exists a considerable number of records of species of the family from Nova Zembla, Northern Siberia, North Russia and Norway, Greenland, Arctic Canada, and Alaska—especially species of the genera *Henlea* and *Mesenchytræus*. Welch has in recent years (20, 21, 22) drawn attention to previous records of Enchytræidæ found actually on ice and snow, and has himself examined and described a number of species from high latitudes, and from snowfields and glaciers. Some of these worms show a resistance to cold that can only be described as marvellous. *Mesenchytræus gelidus* was found "abundantly on the snowfields"; it "also occurred on the snow on the mountain slope in a dense forest of fir and hemlock," and "on the snow below the ice front and outside of the lateral moraines of the Nisqually glacier; . . . when placed on hard-packed snow during their active period, they are able to bore down through it at will; . . . the snow on which they are found is not permanent through the entire season, but melts with the coming of summer, and it therefore appears that a part of their life-history must be spent on or in the ground." *Mesenchytræus solifugus* var. *rainierensis* was "abundant on the higher snowfields and glaciers of Mt. Rainier in early summer; it was found on snowfields which seldom thaw during the summer, and they evidently pass the entire existence, generation after generation, in the snow and ice." Beddard (1) mentions that an Enchytræid has been found frozen in a block of ice, and recovered. Mr. Elton writes that he has subjected the worms which I have named *Enchytræus crymodes* to an experiment in which they were frozen solid and that they survived.

It was thus to be expected that Enchytræids should constitute the bulk of the collection. There is no mention of snow in the data relating to the worms: and since they thus pass at least a part of their life on or in ground free from snow, the conditions under which they live are those of Welch's *Enchytræus gelidus* rather than of *M. solifugus* var. *rainierensis*.

ZOOGEOGRAPHICAL RELATIONS.

The Oligochæta may be divided, with reference to their habitat, into limnic, littoral, and terrestrial forms; and the Oligochæta of Bear Island and Spitsbergen may be classified under these headings as follows:—

LIMNIC.	LITTORAL.	TERRESTRIAL.
<i>Nais josineæ.</i>	<i>Lumbricillus necrophagus.</i>	<i>Henlea brucei.</i>
<i>Henlea heliotrophus.</i>	<i>Lumbricillus agialites.</i>	<i>Enchytræus albidus.</i>
<i>Henlea</i> spp. (2).	<i>Lumbricillus fossarum.</i>	<i>Fridericia leydigi.</i>
<i>Enchytræus crymodes.</i>	<i>Lumbricillus henkingi.</i>	<i>Mesenchytræus</i> sp.
<i>Enchytræus</i> sp.	<i>Lumbricillus pagenstecheri.</i>	
<i>Mesenchytræus</i> sp.	<i>Marionina ebudensis.</i>	
	<i>Enchytræus albidus.</i>	
	<i>Enchytræus crymodes.</i>	

There is no record of the habitat of some of the previously recorded species: of *Lumbricillus fossarum*, which, however, is elsewhere found on the shore, and is therefore so entered here; of *Enchytræus albidus* recorded from Bear Island by Ude, which is also entered as littoral, since all his specimens from Bear Island of which the habitat is recorded were littoral, and the worm is elsewhere common on the shore; and of *Fridericia leydigi*, which is entered as terrestrial, since most of the *Fridericias* are so.

All the smaller Oligochæta, and therefore all the forms which are represented in the present and former collections from Spitsbergen and Bear Island, are easily transported, and hence are of only slight value for considerations of zoogeography. Limnic forms have a great diversity of means of dispersal; they may spread directly throughout a river system—though this, of course, has no bearing on the present enquiry; their cocoons are easily transported in the mud which adheres to the feet of wading birds; some forms are known to encyst, and hence may be transported by birds even in the adult state. As a consequence of this easy distribution, the same genera—sometimes even the same species—are found in widely distant places; the case is similar to that of the Rotifera and Protozoa, of which the same genera and species are found in ponds and streams all over the world. To illustrate by means of an example, there appears to be but one genus, *Branchiodrilus*, of limnic Oligochæta which is peculiar to India, while a number of species are found both in India and England, or India and Europe (species of *Nais*, *Chaetogaster*, *Dero*, *Aulophorus*, *Pristina*, etc.).

Littoral forms, living on the shore and exposed at times to immersion in salt water, have additional means of dispersal. Being, unlike Oligochætes in general, immune to salt water, they can be transported in masses of seaweed; or more commonly their cocoons are so transported, entangled in masses of weed or other detritus. Not only can they take possession of a whole coast, and spread along the shore-line, but they may in this way travel over sea for long distances. *Pontodrilus*, for example, which occurs along the coasts of India, has a circummundane distribution.

Even terrestrial Oligochæta are by no means always dependent on their own unaided activities for enlarging their distribution; there are a considerable number which are especially liable to be transported accidentally—by man or other agencies,—and which show an especial capacity for establishing themselves where they happen to be deposited. The smaller the worms the easier is their dispersal; certain small species of earthworms of the genus *Dichogaster*, which has its proper home in Africa, have spread all round the warmer regions of the globe.

Few, however, possibly none, of the worms of Spitsbergen and Bear Island are exclusively terrestrial. Of those given as terrestrial in the above table, *Enchytræus albidus* is often found on the shore; it is perhaps the most widely distributed of all Euchytræids, and occurs all over Europe, in North America, and in South America as far as Patagonia and Tierra del Fuego, as well as within the Arctic circle in Greenland and Nova Zembla. The species of *Mesenchytræus* found at Cape Boheman among plants in dry tundra was also obtained among mosses on the banks of a freshwater pond, more or less under water, and is therefore limnic as well as terrestrial. The *Henlea* found among *Dryas* etc. on a hill near the coast of Freshwater Bay was also found in the Bruce City region, possibly in a limnic or littoral habitat (details of habitat are wanting for this tube). *Fridericia leydigi*, previously obtained from Spitsbergen, is probably the most strictly terrestrial of all the above species, occurring elsewhere in earth rich in humus and under moss.

There can thus be no question of anything peculiar in the Oligochæte fauna of Spitsbergen and Bear Island. All the genera are easily transported, and all (except perhaps the Naidid genus *Nais*) have previously been found within the Arctic circle—*Henlea* in Nova Zembla, N. Siberia, N. Russia, N. Norway, and in the Canadian Arctic; *Enchytræus* in N. Russia, Greenland, and the Canadian Arctic; *Lumbricillus* in Nova Zembla, N. Siberia, the Canadian Arctic, and Greenland; *Fridericia* in Nova Zembla, N. Russia, and N. Siberia. All these genera also occur in Alaska.

As to whether particular species of Spitsbergen Oligochæta have been evolved locally, or imported, it is as yet impossible to say, until neighbouring lands have been more thoroughly explored. There is some slight ground for supposing that some, at least, may have been evolved on the island. On the whole, no

doubt, it is the commoner species of the neighbouring lands that are already known to us: and on the whole, no doubt, it is the commoner species that, from their frequency, have most chance of being transported. If it had been throughout a case of simple transportation, therefore, we might have expected to find that a larger number of the species of worms were known from elsewhere also.

It seems hazardous to suppose that any of the present Oligochæte fauna could be descended from ancestors existing in Spitsbergen before the glacial period. It is true that we now know species which can live their lives through, and reproduce themselves, on ice and snow. The food of such worms, according to Welch, writing of the specimens from Mt. Rainier, seemed in one case (*Mesenchytræus gelidus*) to be microscopic algæ having the appearance of *Pleurococcus*, and the snow over which the worms were crawling had a red colour due to a minute unicellular plant; in the case of the other worm (*M. solifugus* var. *rainierensis*) the food could not be determined.

But the food-supply of glacier and snow worms must, one would say, be precarious: and it seems dangerous to assume its unfailling presence throughout the long duration of the glacial period.

On the other hand, there are apparently no facts which seem to contradict "the most reasonable hypothesis of the origin of the present fauna—namely, an 'accidental' peopling since the period of maximum glaciation, during which time Spitsbergen has been as widely separated from adjacent lands as it is now."

ON THE "PEPTONEPHRIDIA" OF THE ENCHYTRÆIDE.

Certain structures connected with the first portion of the alimentary canal in a number of Enchytræids are known as "peptonephridia," or sometimes as "salivary glands."

(1) The best known of these structures are a pair of tubules which arise from just behind the pharynx, and extend backwards for some little distance free in the body-cavity. They are well developed, for example, in *Enchytræus albidus*, a worm which is abundantly represented in the present collection. Here the tubules open into a dorsal diverticulum of the alimentary canal just behind the pharyngeal mass: they sometimes extend backwards into segm. v., while sometimes they do not transgress the hinder limit of segm. iv.; their general course is sinuous or contorted, and in addition the outline of the walls is marked by numerous smaller sinuosities or crenations. The diameter of the tubules varies—it may be about 50μ , or may be less; that of the lumen may be 42μ or less; the diameter is least near the origin of the tube from the alimentary canal, where the whole structure is only 16μ thick, and the lumen is very small. The walls are mostly thin, about 4μ thick, but in places are much thicker—as much as 15μ ; numerous nuclei are seen in the walls—in a transverse section of one of the tubes there may be about six, *i. e.* the lumen is intercellular.

(2) In the genus *Henlea* there are often found other organs, situated in the middle line, one dorsally and one ventrally on the œsophagus, in segm. vi., sometimes extending forwards into v., and backwards behind vi. for, it may be, several segments. The association with the wall of the alimentary tube is here much more intimate than in the case of the former structures; these are closely apposed to the wall of the œsophagus for the whole or the greater part of their extent; they may even be contained for a considerable part of their extent within the wall, between the epithelial and muscular coats (Welch, in *H. moderata* (19), which I can confirm in *H. brucei* and *H. heleotrophus*). They frequently give branches.

While the former structures have little about them that can remind the observer of nephridia, these have much more the appearance of the peculiar type of nephridium found in the *Enchytræidæ*—a spongy-looking, scarcely staining tissue, with nuclei but no visible cell-limits; sometimes there seems to be no lumen in the interior—nothing more than the interstices of the spongy cell-substance, sometimes there are irregular spaces and tubular cavities, and sometimes a single well-defined central lumen. They have, however, no ciliated funnel or any kind of internal opening. Cejka, in the worms which he called *Hepatogaster*, states (3) that there are indications of the double origin of these apparently single and median structures; in this I agree (compare the transverse section of a ventral organ of *H. brucei*, fig. 1; the description of the ventral organ in *Henlea* sp. (1), *post.*, and of the dorsal organ in *H. heleotrophus*, where possibly there is no connection between the masses on the right and left sides); while Welch finds that in *H. ochracea* (22) the organs are actually paired, one pair dorsally and one pair ventrally. It is, perhaps, this type of gland which is intended by Friend in his reference to the salivary glands of *H. alba* (7) and *H. inusitata* (8), and to the "special glands" of *H. bisetosa* (8).

(3) There is a third type of organ, which is apparently widely spread in the family. Descriptions of these structures are given for all the newly described species below, and they also occur in the *Mesenchytræus*; I have described and illustrated similar structures in the Indian worms *Enchytræus barkudensis* (14, and see also pl. vi. fig. 1 in 15) and in *Fridericia carmichaeli* (15). Briefly, these organs consist of a pair of rounded, or ovoid and bulb-like, masses of cells, solid, situated behind the pharyngeal mass on the dorsal side of the alimentary tube, and connected with the tube by a stalk, which is at any rate partly solid, but is usually hollow in its proximal portion—*i. e.*, the cavity of the alimentary tube may penetrate the basal portion of the stalk. Ude probably had this type of organ before him when he described the rudimentary salivary glands of *Bryodrilus ehlersi* (16), two small pear-shaped bodies, in which no lumen could be recognized immediately behind the pharynx; and, indeed, since I first met with these structures some years ago, I believe I have myself

conceived them as a rudimentary kind of organs of the first type.

Whether all these structures should go by the same name—whether they are all modifications of one original structure—seems doubtful. Those of the second type are quite possibly nephridia. It will be remembered that the Euchytræids have, as a rule, no nephridia in the first six segments (Bretscher (2) has established a separate genus for a worm in which the first nephridium occurs in segm. iii., the funnel being in ii.); and the occurrence of dorsal and ventral “peptonephridia” in segm. vi., extending thence, it may be, forwards or backwards, or both forwards and backwards, their obviously similar constitution, and their fundamentally paired nature would seem to justify the assumption that they are really the nephridia of segm. vi. which have become associated with the œsophagus. If, however, we look on both dorsal and ventral organs as fundamentally paired (as we seem justified in doing, *v. ant.*), we should then have two pairs of nephridia belonging to segm. vi. In *H. brucei*, in addition to dorsal and ventral “peptonephridia” in segm. vi., there are also in the same segment—indeed in the same section—a pair of ordinary nephridia (the first nephridium being here in segm. vi. with the funnel in v.), i. e., *three* pairs in the one segment.

Whether the organs discharge an excretory substance into the œsophagus, or a digestive juice—or, indeed, whether they discharge anything at all,—is doubtful. Cejka says that the openings are always hard to find in sections; from which phraseology it would seem doubtful whether they actually have definite mouths; Welch does not mention any openings, nor have I found any in my preparations. On the whole, they are perhaps more likely to be excretory, since they have an intimate relation to the blood-spaces (in *H. leptodera* they run in the œsophageal sinus and are directly bathed by the blood (Cejka, 4); in *Hepatogaster* also they are bathed by the blood in the sinus, which may penetrate between the individual cells; I have found the same conditions, *v. inf.*).

But the nephridial nature of the first group of organs, which have for long passed under the name of “peptonephridia”—the sinuous or coiled tubes which extend back, from the pharynx, free in the cœlom—seems doubtful. These do not show the peculiar structure of the Euchytræid nephridium; they have no internal opening; indeed, the only feature that is brought forward to substantiate their nephridial nature is the intracellular lumen. But in *Enchytraeus albidus* (*v. ant.*) the lumen is certainly not intracellular. And in any case there is no fundamental difference between intercellular and intracellular tubes; whether the lumen of any tube is intracellular or not depends on the size of the lumen and the size of the cells of which the tube is composed. Suppose we start with a tube of fair size, in the cross-section of which several cells are seen to bound the lumen; if the size of the tube is diminished, fewer cells will serve to surround the cavity,

and fewer will be seen in any transverse section. Still diminishing the width of the lumen, two cells, and finally one single cell, will go all round the lumen—*i. e.*, only one cell will be seen in any given transverse section of the tube, and the lumen will be described as intracellular. There is thus really no reason for assuming the nephridial nature of these tubules of the Enechytræidæ, and in my opinion they should not be called nephridia.

The third group of structures—the bulb-like organs—are even more unlike nephridia; nor, except for their assumed connection with the tubular organs first described, could it ever be supposed that they were nephridial. It is possible that they are, as has been suggested, vestigial remains of the tubules; they are connected to the same dorsal diverticulum of the alimentary canal as these. In *Enechytræus albidus*, however, I find, along with the typical tubules, and just in front of and lying against the narrow proximal part of these, rather indefinite groups of cells somewhat similar to the bulb-like organs. To establish the homology of the bulb-like organs with the tubules it would be necessary to ascertain definitely whether they do or do not occur along with these, and whether or not intermediate forms exist.

The second group of organs, then—the dorsal and ventral “peptonephridia” of the genus *Henlea*,—may provisionally be taken to be nephridia. But there is no evidence whatever of their digestive function, and I propose for them the name *œsophageal nephridia*.

The first group—the sinuous tubules—are quite possibly not nephridia at all. Since the alternative name *salivary glands* has long been in use for them, I would reject the name peptonephridia in favour of this.

The third group—the solid bulb-like organs—do not seem to be nephridial, and their function, if they have one, is quite unknown. I propose a purely descriptive term, the *postpharyngeal bulbs*, as most suitable for them.

THE GENUS *Henlea*.

Henlea is a large genus, and contains species showing a wide variety of structure. Characteristic of a number of species are the œsophageal sacs in or about segm. viii.; and the question arises whether the presence or absence of these sacs should not be made the basis of a separation into two genera, or at least subgenera.

This course has already been proposed by Friend (7, 3)—forms with œsophageal diverticula to be called *Henlea*, those without to receive the name *Henleanella*. In the second of the papers just referred to, Friend remarks that it would be advisable to make a third group for those species in which the alimentary tube dilates gradually to form the intestine. In a subsequent paper (9) Friend proposes a different criterion for the third group, *viz.*, the origin of the dorsal vessel in the region of the clitellum (in most

species the dorsal vessel arises considerably in front of the clitellum); this third group to be called *Henleana*. These divisions are apparently conceived as subgenera (certainly so in the first two papers).

Friend's suggestion as regards the œsophageal diverticula seems particularly useful. But it is illogical and inconvenient to have a double or triple principle for the simultaneous division of a group; the subgroups will not be mutually exclusive. What, for example, would become of a form with both œsophageal diverticula and a posterior origin of the dorsal vessel—at the same time a *Henlea* and a *Henleana*; or, for that matter, of one with a posterior origin of the dorsal vessel and no diverticula—both a *Henleana* and a *Henleanella*?

In 1910 Cejka (3) established a genus *Hepatogaster* for two species which are obviously nearly related to *Henlea*, the chief distinctive characters being the gradual dilatation of the œsophagus to form the intestine, the presence of a mass of tubules closely surrounding the alimentary tube in segm. viii., and of characteristic longitudinal canals in the epithelium of the hinder end of the digestive tract. The value of the first distinction is doubtful, e. g. in *Henlea heleotrophus* I am not certain whether or not the intestine can be said to arise as a sudden dilatation of the alimentary tube; at first I thought not, but later I altered this in my notes by adding the words "this might be called a sudden widening, and so would agree with the diagnosis of *Henlea*." The second of Cejka's points of distinction occurs also in *Henlea tubulifera* Welch and *H. moderata* Welch; while, as Welch remarks (23), the value of the third distinction as a generic character remains to be demonstrated. Welch retains the genus, though with some doubt. Delphy (5) also considers it as distinct.

The œsophageal diverticula of *Henlea*, when present, may have walls which are fairly smooth and even, or which are variously folded; and I regard the "tubuliferous" condition of *H. tubulifera*, etc., and of *Hepatogaster*, as simply a higher degree of this folding, followed by fusion between the adjacent folds and between the two sacs above and below the alimentary tube. An intermediate condition is that of *H. nasuta* as described by Michaelsen (10, cf. especially pl. fig. 1), where the folding of the walls is very considerable, and there is only a very small central free space, but the two sacs are not fused above and below the œsophagus. The difference between *Henlea* and *Hepatogaster* seems, in fact, to be less than that between *Henleanella* without sacs and *Henlea* with them.

For the present, then, I would retain the genus *Henlea*, but I would recognize three subgenera:—

- (1) *Henleanella*, with no œsophageal diverticula.
- (2) *Henlea*, with œsophageal sacs.
- (3) *Hepatogaster*, with a mass of tubules surrounding the alimentary tube and taking the place of the sacs.

I would disregard the sudden or gradual widening of the tube

in these subgeneric distinctions; but it is possible that a posterior origin of the dorsal vessel will be a sufficient ground for removing out of the genus altogether the forms in which it occurs.

ON THE RELATIONS OF THE GENERA *Lumbricillus* AND
Enchytræus.

I have previously (13) pointed out the close relationship between the above two genera, and described several species with intermediate characters; *Enchytræus dubius*, which I then placed in the genus *Enchytræus*, I should now assign to *Lumbricillus*. Welch also has some remarks that bear on the subject (19, 23).

The distinguishing characters of the two genera may be said to be (1) the setæ—the distal portion of the shaft being straight in *Enchytræus*, curved, so that the setæ have the usual double (sigmoid) curve, in *Lumbricillus*; (2) the copulatory glands—usually absent in *Enchytræus*, usually present in *Lumbricillus*; (3) the testes, divided in *Lumbricillus*, undivided in *Enchytræus*; and (4) the penial bulb—single, compact, encapsuled, and penetrated by the vas deferens in *Lumbricillus*, represented by discrete groups of cells around the end of the duct in *Enchytræus*. In addition, red blood would be in favour of *Lumbricillus*, colourless blood more in favour of *Enchytræus*.

Of the species described in the present paper, *Lumbricillus ægialites* has the straight setæ of *Enchytræus*, and so has *L. necrophagus*; while *Enchytræus crymodes* has a penial bulb of the lumbricilline type, copulatory glands, and hæmoglobin in the blood. These species thus bear out what I have previously written regarding transitional forms, and render a sharp separation between the genera impossible. Still less is there such a sharp distinction between the two as would justify their position as the representatives of two subfamilies, the *Enchytræinæ* and *Lumbricillinæ*, established by Eisen (6).

PERIODS OF SEXUAL MATURITY.

Some of the worms in the collection were sexually mature, others immature. But it is not possible to draw any general conclusions from the data regarding the season of maturity in high latitudes. *Enchytræus albidus* was mature on Bear Island in June and *E. crymodes* in early August in Spitsbergen; but an immature *Enchytræus* was also collected on August 6th. *Henlea heletrophus* and *H. brucei* were mature in early August—*H. heletrophus* also as early as July 10th; but other species of *Henlea* were still immature in early August. The two species of *Lumbricillus* were mature towards the end of July and beginning of August; the *Mesenchytræus*, however, was immature at any rate up to the end of July.

PARASITIZATION.

Finally, I may be allowed to draw attention to the excessive parasitization of most of these worms, which goes much beyond anything that I have previously seen in members of this group. Not only were there numerous parasites, of more than one group of Protozoa, in the alimentary canal, but many of the worms had cysts in the genital region, body-wall, or cœlom, in which spores were forming. It seems probable that the frequent structural changes in the alimentary canal, as well as other changes in the contents of the cœlom, may be due to this parasitization.

SYSTEMATIC.

Fam. NAIDIDÆ.

Genus NAIS Müll. em. Vejd.

NAIS JOSINÆ Vejd.

Bear Island; in littoral region of a tarn near Walrus Bay, in the water; 15.vi.1921. A single specimen, non-sexual.

Fam. ENCHYTRÆIDÆ.

Genus HENLEA Mich.

HENLEA (HENLEANELLA) HELEOTROPHUS, sp. n.*

Spitsbergen; among mosses on the bank of a fresh-water pond, more or less under water, Bruce City. August 1st-8th, 1921.

Spitsbergen, Bruce City region (no data regarding habitat); 10.viii.1921. One specimen from each of these tubes.

Length 8-10 mm.; diameter .4 mm. Segments 40, with a few more not yet differentiated at the hinder end. Colour brownish in the first tube, black in the second (fixed with Bouin). Prostomium bluntly triangular, the triangle being about equilateral. Head-pore between prostomium and first segment. No dorsal pores.

Clitellum on segments xii. and xiii., well marked.

Setæ enchytræine in form (*i. e.*, straight in their distal portion), the tip moderately sharply pointed. In front of the clitellum the ventral bundles have apparently four setæ (not well seen), behind the clitellum 4, 5, 6, and once 7; the lateral bundles have usually five setæ, sometimes 4 or 6, in front of the clitellum, and behind the clitellum 4, 5, 6, once 7, and once 8.

The "taste organ" on the floor of the pharynx is similar to that described for the next species, except that its base of attachment appears to be a little narrower.

* 'Ελεϊότροφος, bred in the marsh.

The septal glands are bulky, the last, in segm. vi., causing septum 6/7 to bulge back very considerably.

Dorsal and ventral œsophageal nephridia are present, but less conspicuous than in the next species. The dorsal nephridium is double, consisting of two masses, one on each side of the middle line, attached behind to the dorsal side of the dorsal vessel near the angle which the vessel makes with the septum (6/7) and laterally to this on the anterior face of the septal gland; the masses have perhaps a small connection with each other across the middle line. Each is very irregular in shape, and the attachment to the dorsal vessel and septal gland is relatively narrow; portions of the mass consist of long strings of cells extending forwards and upwards in the segment.

The ventral nephridium is contained wholly in the œsophageal wall, and is rather indistinct—indeed, in one of my two series of longitudinal sections it is scarcely to be made out; it is not obviously paired, and extends behind into segm. vii.

A pair of postpharyngeal bulbs are present—small solid groups of cells behind the pharyngeal mass, continuous with a dorsal upfolding of the œsophageal epithelium. These structures may be compared with those described in the account of the next species; but here they are very much less definite, the knobs of cells less distinctly limited, the lumen of the upward fold of œsophageal epithelium much less marked, indeed hardly present, and the whole smaller.

Chloragogen cells begin in segm. vii.; in this segment, however, they are only scanty.

The œsophagus expands to form the intestine in segm. viii. In this segment there is a slight invagination backwards of the œsophagus into the broader intestine behind; there are no diverticula. In each of the segments behind vii. the canal is swollen out into an ovoid shape, and this is the case in the genital segments also. There are no chylus-cells.

The celomic corpuscles are large, granular, and elliptical, oval, or fusiform in shape, of an average length of 29μ ; small nuclei, with a central nucleolar dot, are visible in some, though not distinctly discoverable in all.

The dorsal vessel originates in the anterior part of segm. ix. as a sudden swelling just behind the septum; it contains numerous corpuscles. The blood was probably colourless.

The nephridia have a relatively large anteseptal portion in which the central lumen undergoes some windings; the post-septal portion is ovoid, and not large; in one specimen the duct appears to be prolonged back from the hinder end of the body of the organ, and lies on the body-wall; in a second, the duct can be seen in sections to come off from the under (or under and outer) side of the postseptal portion considerably in front of its hinder end.

The sexual organs are more completely developed in the second specimen (taken on the 10th of August), which will therefore be described.

The testes are small, and not lobed. Sperm-morulae and the early stages of spermatozoa are free in segm. xi., but not in large numbers.

The male funnel is small, subspherical in shape, $108\ \mu$ in diameter, with spermatozoa clustering round its mouth. The first portion of the vas deferens is of a diameter of $15\ \mu$, but this is only for a very short distance on both sides of the septum, and the main part of the duct forms a very narrow tube $6\ \mu$ in diameter, packed tightly in a coil just behind the septum and entirely in front of the level of the male pore. The penial body is of the lumbricillid type, subspherical in shape, $120\ \mu$ in diameter, compact, with a definite outline and contained in a definite muscular capsule.

The ovary is small; large ova are contained in segm. xii.

The spermathecal duct is straight for the most part, of some length, $28\ \mu$ in diameter, directed downwards and forwards; towards its ental end it bends inwards; there are a few pear-shaped lobules of cells around its ectal end, but these may be peritoneal aggregates and not epithelial gland-cells. The ampulla is only slightly dilated, measuring $56\ \mu$ in diameter; the two ampullae are continuous across the middle line—there is not even a narrowing of the lumen to demarcate one from the other. There is no connection between the lumen of the oesophagus and that of the ampullae; the structures do not anywhere come into contact. The length of the conjoined ampullae is $160\ \mu$ (computed—it extends through 20 longitudinal sections each of a thickness of $8\ \mu$).

There are no copulatory (ventral) glands.

The first specimen is altogether smaller than the second, and was collected a little earlier. The diameter of the male funnel is $75\ \mu$; though here, too, spermatozoa are clustering round the mouth. The penial body is also about $75\ \mu$ in diameter. The spermathecal ampulla is no wider than the duct, though the epithelium is much lower and the lumen therefore more capacious; the inner ends of the ampullae are not in contact either with the oesophagus or with each other; there is an interval of about $16\ \mu$ between the ampullae of the two sides.

HENLEA (HENLEA) BRUCEI, sp. n.

Spitsbergen; dry tundra, among *Dryas*, etc., on hill near coast, Freshwater Bay, Prince Charles Foreland; 10.vii.1921. A single specimen.

Spitsbergen; Bruce City region (no data concerning habitat); 10.viii.1921. A single specimen.

Spitsbergen; among plants growing on shingle of raised beach, Bruce City; 11.viii.1921. Two specimens.

Length 6–8 mm.; diameter $\cdot 31$ – $\cdot 46$ mm. Segments 40–43. Colour brown (probably in part at least due to preservative). Prostomium short and rounded. Head-pore on dorsal surface of prostomium. No dorsal pores.

Setæ enchytræine in form ; there may, however, be a hint of a distal curve. In some bundles the inner setæ are smaller and slenderer than those at the ends of the bundle (*Fridericia* arrangement). In front of the clitellum the ventral bundles contain 4 or 5 setæ, occasionally 3 ; the lateral bundles have 3 or 4. Behind the clitellum the ventral bundles have 4 or 5, occasionally 3 or 6 setæ ; the lateral 4, 5, or 6, occasionally 3, or in the last segments even two.

The clitellum roughly covers segms. xii. and xiii. ; but in a specimen with fully developed sexual organs one-third of xi. was included, and a small portion of the hinder end of xiii. (about a quarter) was free.

A taste-organ is present on the floor of the pharynx, in front of the level of the dorsal pharyngeal mass and of furrow 2/3. It is best seen in longitudinal sections, according to which it is a solid transverse ridge, bent somewhat forwards, with a narrow free edge. Its base is slightly narrowed (antero-posteriorly, as seen in longitudinal sections), and its total height is about five times the antero-posterior thickness of its base of attachment. It is composed of elongated cells, and being solid is distinguishable from the other ridges of the ventral pharyngeal wall, which are merely folds of the epithelium. In one specimen the pharynx is being everted ; it is the ventral wall alone that comes forward here, and the taste-organ is at the tip of the everted part, so that it comes just onto a level with the mouth-opening, or in one or two sections rather further, projecting a little from the mouth. Some deeply staining matter is apparently being taken in.

The septal glands are bulky ; the last is in relation with septum 6/7, covering both sides of it and thus occupying part of segm. vii.

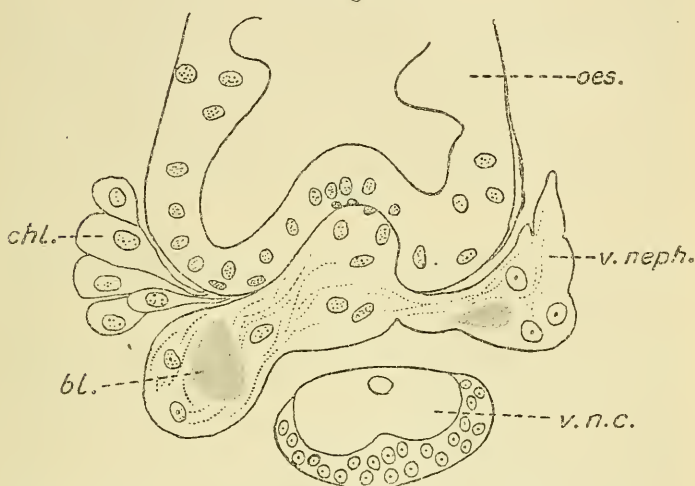
There are dorsal and ventral œsophageal nephridia. The dorsal organ ends behind in segm. vi., and gives a branch dorsalwards just in front of its ending ; in front it gets into segm. v. in one series of sections, and ends some distance above the œsophagus and not in contact with it. In another specimen, cut into longitudinal sections, it is confined to vi., and appears as a projecting mass dorsally on the œsophagus, spongy in texture, hardly staining, irregular in shape, and in intimate connection with the dorsal vessel ; indeed, a proper wall of the dorsal vessel is wanting, or cannot be distinguished, and the blood appears to be contained within a sinus in the nephridial tissue.

The ventral nephridium ends behind by branching into two at a level just in front of that of the end of the dorsal organ ; each branch extends laterally for some distance, and then terminates by turning somewhat forwards. These branches form the chief part of the organ ; the median portion, on the ventral œsophageal wall, is soon lost, and does not seem to get forwards into segm. v. This nephridium also is in close relation with blood-spaces—in this case those of the alimentary wall (text-fig. 1).

In another specimen both organs appear to be confined to segm. vi.

Besides these organs, which have, from their texture, more or less the appearance of nephridia, there is behind the pharynx a narrow diverticulum of the alimentary tube, wedge-shaped or conical as seen in longitudinal sections, pointed above, directed dorsalwards and backwards, and at its tip connected with a pair of solid knobs, the postpharyngeal bulbs. Each knob is a cellular mass, ovoid or somewhat club-shaped, with the long diameter continuing the direction of the diverticulum. The length of the diverticulum is $120\ \mu$, that of the bulbs $36\ \mu$, and the thickness of the latter $20\ \mu$.

Text-figure 1.



Henlea (Henlea) brucei; transverse section through oesophagus and hinder end of ventral oesophageal nephridium. *Bl.*, blood in sinus-like cavities of nephridium; *chl.*, chloragogen cells; *oes.*, oesophagus; *v.n.c.*, ventral nerve cord; *v.neph.*, ventral oesophageal nephridium.

The oesophagus is narrow as far as segm. viii., where it swells out into the intestine. The canal is thenceforwards swollen segmentally in an ovoid manner, and is not constricted in the genital segments. There are no chylus-cells.

Chloragogen cells begin, but only scantily, in the posterior part of segm. vi.

In segm. viii. is a pair of oesophageal diverticula. Each is sac-like, with folded walls; each originates from the alimentary tube at the hinder end of the segment, and extends forwards to its anterior limit. There appears to be some variation in the exact manner of origin of the sacs; in two series of sections, both longitudinal, the sacs have independent openings into the oesophagus,

one on each side; in a third, a transverse series, the two sacs join dorsally above the alimentary tube before they enter it.

The dorsal vessel originates in segm. viii. between the two œsophageal sacs. The blood was colourless (no red staining with eosin—absence of hæmoglobin).

The cœlomic corpuscles are few in number, large, disc-like, oval, about $30\ \mu$ in long diameter; the body is granular, and a nucleus is present, $3\ \mu$ in diameter, with a more deeply staining dot-like nucleolus. In one specimen the corpuscles were distinctly smaller than in the others—only $20\ \mu$ long.

The preseptal portion of the nephridia is often pyramidal in shape, narrow at the free end and broader where it joins the septum; in any case it is of some length (40 – $60\ \mu$). The postseptal portion is broad and ovoid or pear-shaped, with the wider portion behind. The duct is narrow, cylindrical, and long—as long as or longer than the postseptal portion; it is curved, arched, or even bent into a loop with the convexity backwards.

The testes are small, compact, either slightly lobed or not, but not divided (that is, not split up into a number of elongated pear-shaped divisions attached in a cluster at their narrow ends, as is the case in the genus *Lumbricillus*). A few sperm-morulae lie loose in segm. xi.

The funnels are small, with a distinct rim of nucleated cells, and resemble what is known as a "thistle-funnel." Each is rather longer than broad; in different specimens they measured 92 by $56\ \mu$, 100 by $72\ \mu$, and 120 by $100\ \mu$.

The first portion of the vas deferens, which lies in front of the septum, is $16\ \mu$ in diameter; it very soon pierces the septum, and after maintaining its former size for a short distance, contracts to a very narrow tube, 5 – $8\ \mu$ in thickness, which lies in a close coil ventrally in the anterior part of segm. xii. just behind the septum and behind the position of the funnel.

The penial body is of the lumbricillid type, spherical, compact, of definite form, enclosed in a muscular capsule, about $120\ \mu$ in diameter. In one specimen it appeared to be rather shorter in vertical diameter, $120\ \mu$ high by $160\ \mu$ long.

The ovaries are small, and consist of club-shaped lobes. Ova lie in segm. xii.

The spermathecal duct is cylindrical, about $30\ \mu$ in diameter, with thick walls and small lumen; there are no gland-cells either on its course or round its ectal end. The ampulla is cylindrical or ovoid, thin-walled, $40\ \mu$ in cross-section. There is a direct connection between the ampullae of the two sides across the middle line dorsal to the œsophagus—a fairly wide passage $24\ \mu$ in diameter, with a lumen of $16\ \mu$; this connection between the two ampullae is contiguous to the œsophageal wall, but there is no communication with the cavity of the œsophagus, a double layer of cells, the alimentary epithelium and the spermathecal epithelium, always intervening.

In another specimen, although the ampullae were more swollen

than in that from which the above description was taken and contained spermatozoa, I could not make out any connection between the two chambers: here again there was no communication between the cavity of the spermathecal apparatus and that of the œsophagus.

There are no copulatory glands.

The present species is not very unlike the common *H. nasuta*, which has been recorded from N. Russia and N. Siberia. It differs, however (I take as the standard of comparison Welch's description, 22), in being smaller, in having a blunt prostomium, in the shortness of the ventral œsophageal nephridium, in the male funnel being here more nearly spherical, in having no glands at the ectal end of the spermathecal duct, in having a broader communication between the two ampullæ, and in having no communication between spermathecæ and œsophageal lumen.

It also approaches *H. urbanensis* Welch, found in Illinois (19). The present species is smaller than that one, has fewer setæ in the ventral bundles, the ventral œsophageal nephridium is smaller, the dorsal vessel originates in viii., not in ix., the male funnel is much shorter, there are no gland-cells round the ectal end of the spermathecal apparatus, and no communication with the alimentary canal.

In many species of *Henlea* the inner ends of the two spermathecæ are bent downwards, meet, and join to form a common passage which enters the dorsal surface of the œsophagus. In both the species here described the condition is rather different; instead of meeting at an angle, the spermathecæ of the two sides are continued directly into each other across the middle line, and there is no communication with the œsophagus. This absence of communication is just possibly due to the specimens not being completely mature—the œsophageal connection being probably the last portion of the apparatus to form,—though from the condition of the other organs this hardly seems to be the case.

HENLEA (HENLEANELLA) sp.

Spitsbergen; among mosses on the bank of a fresh-water pond, more or less under water, Bruce City; from August 1st to 8th. Five specimens, none fully sexual.

Unfortunately the specimens are rather too immature to describe. They belong to that section of the genus which has no œsophageal sacs.

The dorsal and ventral œsophageal nephridia attracted my attention. The dorsal is seen in segm. vi. with a central lumen and lateral branches of some size; from this portion is continued back a solid cellular cord, regular in form, cylindrical and well defined in the middle line on the œsophagus as far as segm. x.; the cord, although it has no lumen, seems to take the place of the dorsal vessel, which is not separately visible. The ventral

œsophageal nephridium is confined to segm. vi.; it consists mainly of two masses, one on each side of the middle line; each mass has folded walls and a considerable lumen.

HENLEA (HEPATOGASTER) sp.

Spitsbergen; among mosses on the bank of a fresh-water pond, more or less under water, Bruce City; end of July and beginning of August 1921. A single specimen.

This specimen was taken near the last, but in a different moss-zone. The œsophageal diverticula take the form of a number of communicating tubules, as in the worms called *Hepatogaster* by Cejka (3) and in *Henlea tubulifera* and *H. moderata* as described by Welch (18, 19). I could not discover whether there were or were not dorsal and ventral œsophageal nephridia, as my sections of the worm were not very successful. The dorsal vessel begins in segm. ix.

Genus LUMBRICILLUS Örst.

LUMBRICILLUS ÆGIALITES, sp. n.*

Spitsbergen; in seaweed at high-tide mark on shore, at head of Klaas Billen Bay in Icefjord, by Bruce City; last week in August 1921. Numerous specimens.

Length up to 17 mm.; maximum diameter .65 mm. Colour brownish (fixed in Bouin). Segms. 52-53. Prostomium rounded, hemispherical. Head-pore not made out with certainty, probably present.

A cuticle is not usually separately discernible; it is sometimes seen in the anterior segments, when it is not more than $1\ \mu$ in thickness.

Fairly numerous deeply staining (with hæmatoxylin) mucous cells are seen in transverse rows in the surface epithelium—not, however, causing eminences on the surface.

Clitellum $\frac{1}{2}$ xi.-xiii. (=2 $\frac{1}{2}$), not very well marked.

Setæ enchytræine (distal portion straight), blunt. In the ventral bundles in front of the clitellum 4 or 5 setæ; behind the clitellum 3, or at the hinder end 2. In the lateral bundles in front of the clitellum 3; behind, 3 in most segments, 2 at the hinder end.

The septal glands are in segms. iv., v., and vi.; septum 6/7 is bulged backwards by the last gland.

There are no salivary glands. There are, however, a pair of postpharyngeal bulbs—club-shaped structures in connection with the dorsal wall of the alimentary tube at the junction of pharynx and œsophagus. Their total length is $240\ \mu$; they are constituted by a solid mass of cells in the form of a knob, and a stalk which

* 'Αγιάλιτς, of the shore.

is attached to a small diverticulum of the alimentary tube; this might be expressed by saying that the proximal portion of the stalk is hollow, its cavity communicating with the alimentary lumen.

In the œsophagus are large numbers of parasitic Ciliata. The œsophageal epithelium is being shed *en masse* into the lumen of the canal; in some places also the cilia are being detached and shed.

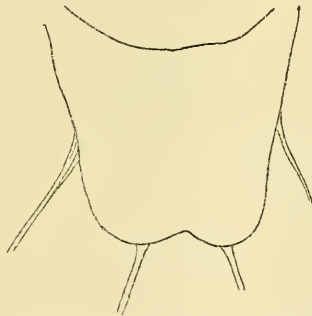
The intestine dilates gradually after passing through the genital segments, about segm. xiii.

Chloragogen cells begin in segm. vi.

The coelomic corpuscles have a length of 16–24 μ ; in shape they are elongated, fusiform, pear-shaped, or oval. They are not very definite structures, and often seem to be disintegrating and of irregular outline. Some, broader than most, are nucleated.

The dorsal vessel begins in segm. xiv. The blood from its staining reactions (it stains a pinkish-brown with eosin) probably contained hæmoglobin.

Text-figure 2.



Cerebral ganglion of *Lumbricillus agialites*.

The anteseptal portion of the nephridia consists of the funnel only. The postseptal portion is spindle-shaped. The stout duct is the hinder end of the organ bent downwards and inwards, sometimes forwards as well; sections of the duct are rather characteristic—always oval in outline and showing radial striations in the wall.

The cerebral ganglion (text-fig. 2) has a slightly concave anterior border; the posterior border is slightly indented in the middle line and rounded on each side of the median indentation. The ganglion is about as long as broad, and is broader in front than behind.

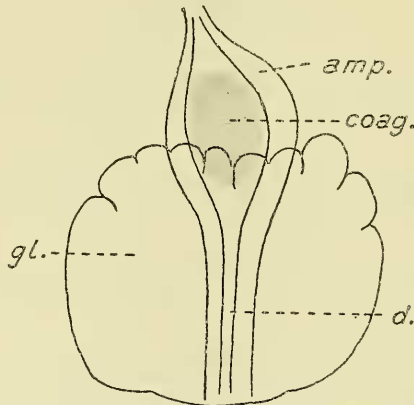
The testes have the usual constitution in the genus. Each consists of a number of elongated lobes ("divided" testes, using Welch's term), which extend into segms. x. and xi.; each lobe is contained in a membranous sac, which in some cases may be fairly

substantial, with a number of much elongated nuclei in its wall. The substance of the lobes consists proximally of a mass of cells only; further from their attachment they dissolve into spermomulae, still contained within the sacs. There is a large vacancy in septum 10/11; as already said, the lobes of the testes extend into both segments.

The funnel is short and stout—about twice, or at any rate not more than three times, as long as wide. In a specimen in which the funnels were isolated by dilaceration they were not more than $1\frac{1}{2}$ times as long as wide. The vas deferens is long and much coiled, but in the dilacerated specimen not so tightly as in the next species; it is confined to segm. xii.; in diameter it measures 10–12 μ .

The penial body is compact, subspherical in shape, in diameter 130–160 μ , of the usual lumbricilline type, with a strong muscular capsule. It causes a slight projection on the surface.

Text-figure 3.



Spermatheca of *Lumbricillus agialites* isolated by dilaceration. *Amp.*, ampulla; *coag.*, coagulum in ampulla; *d.*, duct; *gl.*, mass of gland-cells.

The ovaries are in segm. xii.; loose ova are present in xii. and also in xiii. There is no ovisac. The female funnels are merely backward bulgings of the septum. The oviducts are not as yet patent.

The spermathecal ampulla is smoothly ovoid, 90–100 μ in diameter, and communicates with the œsophagus by a rather narrow neck. The duct is straight and as long as the ampulla. A large mass of gland-cells surrounds the duct, and takes up all the space between the parietes and the ampulla—even surrounding the basal half of the ampulla; the upper margin of this mass of gland-cells is slightly lobed (text-fig. 3).

Copulatory glands (“ventral glands”) are present in segments

xiv. and xv. They are small, and the wings do not meet above the cord, all the dorsal surface of the cord being free. The lateral extent of the wings is not great; each measures about twice the transverse diameter of the cord, and does not reach outwards more than halfway towards the ventral setal bundles. They are not composed of several layers (as in *L. nervosus*, according to Ude).

Besides the parasites in the œsophagus, others were found in the testicular region. Here there are a number of sacs, each containing what appear to be stages in the formation of spores.

It is extremely difficult to know which of the worms described by the older writers, and designated by names that are still in use, correspond to forms met with at the present day. The older descriptions are so very scanty, according to present-day requirements, that they frequently fit several of the species now recognized. In course of time, other descriptions have been published under the older name, supposedly referring to the same worm; particulars have been taken from these descriptions and incorporated in the diagnoses. The result is a composite picture, which may or may not represent the worm which the original describer had under his eyes. Another worm may come up, which may fit the original description equally well—and may therefore be identical with the original species; but it will have to be described as new, since it is not characterized by the accretions which have gathered round the original diagnosis.

Thus the original description of *Lumbricillus pagenstecheri* (Ratzel) is very scanty, but it has been added to by Vejdovsky and Ude. The present worm seems to differ from the original description (12) in having the setæ fewer in number (2-5 as against 6-10, 7-8 being the commonest numbers in the original), and straight (those of the original, while described as straight, had, nevertheless, a slight curve at their sharp end—"mit leichter Biegung an der scharfen Spitze"), with blunt instead of sharp points. From the diagnosis in the 'Tierreich' (11), which embodies what I have called later accretions, it differs in having small instead of large copulatory glands, which leave the whole of the dorsal surface of the cord uncovered; and in having the whole of the spermathecal duct closely covered with gland-cells, instead of loosely; the shape of the cerebral ganglion also differs considerably.

From *L. henkingi*, described by Ude from Bear Island, the present form differs in not having S-shaped setæ, in the origin of the dorsal vessel in xiv. (instead of in xiii.), in having copulatory glands in xiv. and xv. (instead of in xiii. and xiv.), and in the fact that these glands are here very much smaller (in *L. henkingi* the wings of the glands are four times as extensive as the greatest diameter of the cord, and they reach outwards somewhat beyond the setal bundles).

The present species is not very unlike *L. franciscanus* Eisen, from California (varieties of the species also from Pribilov Islands

and Alaska). It differs apparently in the shape of the setæ, in the place of origin of the dorsal vessel (in *L. franciscanus* it arises, according to the short diagnosis, in segm. xiv. or xv., but in the detailed description it "has already arisen in xvi. How much further posteriorly it extends I do not know, as I did not section further"), in the rather greater extent of the clitellum, and in the more restricted distribution of the copulatory glands (clitellum over segms. xii.-xiii., glands in xiv.-xvi. in *L. franciscanus*).

LUMBRICILLUS NECROPHAGUS, sp. n.*

Spitsbergen; in dead seal, at high-tide mark on shore, by Bruce City at head of Klaas Billen Bay in Icefjord; 25.vii.1921. A number of specimens.

Length up to 15 mm.; maximum diameter 4-55 mm., but many are thinner. Colour pale yellowish. Segments 51-53. Prostomium blunt, rounded. No mucous cells in epidermis.

The surface is covered with a moderately thick cuticle, considerably thicker and more noticeable than that of the last species.

Clitellum $\frac{1}{2}$ xi.-xiii. (= $2\frac{1}{2}$): in sections the extent appears to be rather different—it includes a little of xi. and gets slightly on to xiv. also.

The setæ are enchytræine in form (I think I have occasionally detected a hint of a distal curvature) and blunt, rounded, or even squarish at their tips. The ventral bundles contain in front of the clitellum mostly 4 (occasionally 5 or 3) setæ and behind the clitellum 3. The lateral bundles have usually 3 (occasionally 4 or 2) in front of, and 3 or 2 behind, the clitellum.

The septal glands are bulky, the last, in segm. vi., causing a backward bulging of the septum.

The postpharyngeal bulbs arise from a transversely placed groove-like evagination of the alimentary tube behind the pharyngeal mass. Each is a slender elongated cord of cells, rather swollen at its distal end, its general direction nearly vertical, and solid except in its proximal third or less, where there is a narrow lumen.

Chloragogen cells begin in segm. v.

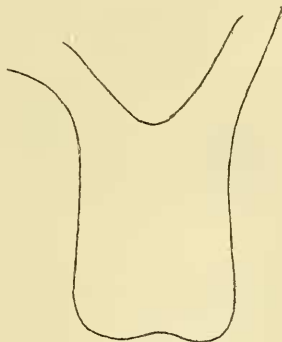
The œsophageal epithelium is being thrown off into the cavity of the tube; the cells lie loose in the lumen, and there is a copious granular substance between them and the remainder of the œsophageal wall. Similarly, the intestinal epithelium is disintegrating or has disappeared over large areas; the intestinal tube is full of a faintly staining granular substance, or of what is apparently a disintegrating cell-mass; sometimes the epithelium is separating in sheets, and the lumen is half empty. The intestinal tube is much swollen out, and the cœlom is almost obliterated in parts, the nephridia being pressed against the

* Νεκροφάγος, devouring corpses.

body-wall. Extreme degeneration may exist throughout the whole of the alimentary tract behind the septal glands.

This condition might be due to the presence of parasites—there are a number of such, elongated, cylindrical, with a nucleus of corresponding shape, in the œsophagus (probably Ciliates, though no cilia could be made out on them), as well as a number of small cysts in the tissues. Still, the usual Ciliate parasites of the œsophagus of Enchytraëids do not as a rule cause such degeneration. It might perhaps be due to the parasites of the tissues, through their metabolic products, which may have a specific action on the alimentary epithelium. Or one might attribute it to the food (assuming that the worms were taking in material from the body of the dead seal in which they were found), but for the fact that the last species also showed degeneration of the alimentary epithelium, though not to such an extreme degree as these worms.

Text-figure 4.



Cerebral ganglion of *Lumbricillus necrophagus*.

A lightly staining, almost perfectly homogeneous, very slightly granular coagulum, containing many nuclei, almost fills up the cœlom in the anterior part of the body. There are no definite lymph-corpuses of the type of those found in the former species; but the nuclei in the coagulum just described seem to have belonged to corpuses which have degenerated. These changes seem to go along with those in the intestine, and are doubtless due to the same cause.

The dorsal vessel begins in segm. xiv. The blood contained hæmoglobin.

The anteseptal part of the nephridia is quite small and shortly cylindrical. The postseptal portion is elongated and is continued behind into the duct, which has the same structure as in the last species. The whole is flattened against the body-wall.

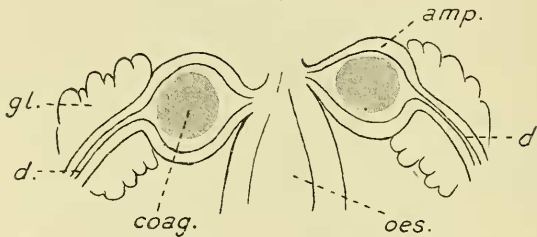
The cerebral ganglion is rectangular in general outline (text-fig. 4), the sides being approximately parallel and the length

about one-third greater than the breadth. The posterior border is very slightly indented, and the posterior angles are well rounded.

The testis consists of numerous lobes or divisions, each contained in a definite sac; in each sac the distal portion of the contents consists of morulae and developing spermatozoa. The lobes are contained in segms. x. and xi.; they originate from the parietes on both sides of the attachment of the septum. Numbers of spermatozoa are free in segm. xii. at and behind the level of the penial bodies and as far back as the hinder end of the segment. Numerous cysts containing developmental stages of parasites occur amongst the testis-lobes.

In two specimens from which the male deferent apparatus was isolated by the method of dilaceration, the funnels appeared to be only a little longer than broad—not more than half as long again as broad. In one specimen, in which they were well seen, they were rather triangular in shape, the posterior end (where the vas

Text-figure 5.



Spermatheca and intervening part of oesophagus of *Lubricillus necrophagus*, isolated by dilaceration. *Amp.*, ampulla; *coag.*, coagulum in ampulla; *d.*, duct; *gl.*, mass of gland-cells; *oes.*, oesophagus.

deferens is given off) being narrow. In sections also the funnels appeared short and stumpy, the proportions varying, but apparently most often about half as long again as broad.

The vas deferens is narrow, $8\ \mu$, and is confined to segm. xii.; it is tightly coiled, and is seen in sections as a number of windings squeezed close against the body-wall. The penial body is of the lumbricillid type, ovoid, somewhat flattened vertically, .19 mm. long and .14 mm. high.

The large ovary, in segm. xii., is also branched into lobes.

The spermathecal ampulla is shortly and stoutly pear-shaped, drawn out above into its oesophageal connection; there appears to be a communication between the cavities of the spermatheca and of the oesophagus. The duct is well marked off, longer than the ampulla, and surrounded by a large lobed mass of gland-cells which fills up the space between the parietes and the base of the ampulla (text-fig. 5).

Copulatory glands occur in segms. xiv. and xv. They are small,

not covering the dorsal surface of the cord; their shape is slightly different from those of the last species; the lateral expansions are level with the dorsal surface of the cord, so that there is a straight line all along; in the former species the wings rise above the level of the cord.

I was at first extremely inclined to unite these worms with the last species; and I am still not quite certain that they are specifically distinct. The chief difference is that there are no mucous cells in the present specimens; they were stained in exactly the same way as the former, yet the mucous cells are extremely obvious at the first glance in the former preparations, while they are entirely absent in these. The thicker cuticle also seems to be a distinction, as well as the shape of the cerebral ganglion and, possibly, though doubtfully, the different shape of the copulatory glands. The appearance of the two worms is also very different; *L. ægialites* is dark brown (perhaps in part due to the fixative—Bouin), *L. necrophagus* pale and semi-transparent (fixative not stated); *L. ægialites* appears much stouter than *L. necrophagus*, though actual measurements hardly bear this out. But the two are closely related; whether the differences can be put down to the different manner of life in the two cases seems doubtful, since one can hardly suppose that the occurrence of these specimens in a dead seal was more than accidental.

Genus ENCHYTRÆUS Henle em. Mich.

ENCHYTRÆUS ALBIDUS Henle.

Bear Island; Walrus Bay (S.E. of island); by shaking plants of dry tundra; 15.vi.1921. Four specimens, some of them (? all) mature.

Same locality; among plants on shaly slope; 22.vi.1921. Two specimens, both mature.

Same locality; among plants on top of hill (dry tundra); 22.vi.1921. Two specimens, both mature.

ENCHYTRÆUS CRYMODES, sp. n.*

Spitsbergen; among mosses on the bank of a fresh-water pond, more or less under water, Bruce City; end of July and beginning of August 1921. Several specimens.

Spitsbergen; moss by salt marsh, probably reached by extremely high tides, near Bruce City; 8.viii.1921. Numerous specimens.

Mr. Elton adds a note to the above data:—"These" (the second of the two batches) "were observed to be living on live moss leaves, and seemed to occur among these, but not in the decaying parts of the moss. They survived being frozen solid, in an experiment which I did."

* Κρυμώδης, icy cold, frozen.

Length 8-9 mm.; diameter .4 mm. Colour brownish. Segments 34-38. Prostomium bluntly triangular, the triangle being about equilateral. Head-pore between prostomium and first segment; no dorsal pores.

Clitellum not well marked (or scarcely formed), xii.-xiii. (=2).

Setæ enchytræine in form, tip fairly sharp. In front of the clitellum both ventral and lateral bundles have three setæ, occasionally four: behind the clitellum they have two only.

The hindmost septal glands are in segm. vi.

There are no salivary glands of the type of those of *E. albidus*, but, as in the species of *Lumbricillus*, there are a pair of post-pharyngeal bulbs. These are small, knob-like, ovoid cell-masses immediately behind the pharynx, connected with the first part of the œsophageal tube by solid conical cell-aggregates. The knobs are separated from each other in the middle line by a muscular strand. In other preparations of these same worms the structures are not so clearly seen—either there is actually some variation or the plane of section is not so favourable.

Chloragogen cells begin scantily in segm. v.

The œsophagus remains narrow till past the genital segments; it begins to widen in xiii. and the intestine is fully established in xiv. There are numerous sporozoan parasites in the epithelium of the œsophagus. There are no chylus-cells in the alimentary tract.

The dorsal vessel originates in segm. xiii. The blood stains slightly with eosin; probably there was a small amount of hæmoglobin in it originally.

Celomic corpuscles are present as irregular discs, staining little, fusiform or oval in shape, 32μ in average length (the limits being $30-40\mu$), nucleated; but they are relatively few in number.

The nephridia (text-fig. 6) have a small narrow anteseptal portion; the postseptal portion is swollen out, shortly ovoid or subspherical. The duct is long, relatively thick, and leaves the outer side of the postseptal mass, passing backwards for some distance and then downwards—even somewhat forwards in some sections.

The testes are bulky in the present specimens; they are slightly lobed in their distal portions. Some of the sexual cells are becoming metamorphosed into sperm-morulæ and spermatozoa, and these are bound together and to one of the lobes of the testis by an apparently incomplete sac. These sacs appear to be rupturing, and so allowing their contents to escape. In one specimen there is a mass of genital cells in segm. ix.

The funnels are long and narrow, as much as 6-8 times as long as broad. They may push right through the septum into segm. x., in which the anterior half of the funnel may thus be contained; or the anterior end may be reversed and push back septum 11/12 so as to form a sac, in which the anterior part of the funnel is contained. The mouth of the funnel has a distinct lip.

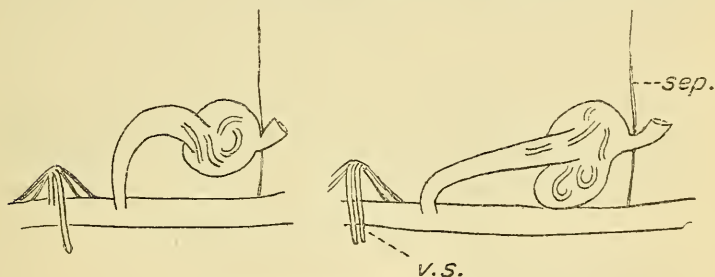
The vas deferens is narrow, 7–12 μ in diameter, and forms numerous close coils in segm. xii., to which it is confined. It pierces and penetrates the penial body.

The penial body is of moderate size, .12 mm. in diameter, compact, of the lumbricilline type, spherical, with a definite muscular capsule.

The ovary, in segm. xii., is bulky. Septum 12/13 is bulged back by ova contained in segm. xii. in such a way as to form an incipient ovisac.

The spermathecae have each a relatively small and thin-walled ampulla, subspherical in form, 80–120 μ in diameter. The duct is thick-walled with high epithelium, 70–80 μ in diameter, cylindrical, longer than the ampulla and nearly as thick. There are a number of pyriform groups of cells round the ectal end of the duct. The ampulla probably communicates with the cavity of the oesophagus at full sexual maturity, though such a patent communication was not visible in my specimens; in one, however,

Text-figure 6.



Nephridia of *Enchytræus crymodes*.

Sep., septum; *v.s.*, ventral setal bundle.

the epithelium of the two organs (ampulla and oesophagus) was continuous. The two ampullæ may be separated from one another by a part of the oesophagus; but in another case they were contiguous—indeed, their walls were fused together. In both these cases the cavity of the ampullæ contained spermatozoa.

Copulatory glands are present, though small, in segms. xiii. to xvi. and perhaps xvii. They do not cover the dorsal surface of the cord at all. There is a small rounded papilla over the position of each gland where the gland-cells come to the surface.

ENCHYTRÆUS sp.

Spitsbergen; among moss in marshy (fresh-water) area near Bruce City; 8. viii. 1921. A number of specimens.

I regret that this worm is rather too immature to justify my giving it a name. I append a few particulars, which may enable it to be identified when next it is met with.

Length 3-3.5 mm.; diameter .17 mm. Segments 22, or 22 with some incomplete segments behind. Colour dark. Setæ enchytræine in form, two per bundle throughout the body. No salivary glands. Cœlomic corpuscles fairly numerous, oval, nucleated, 12-14 μ in length. The dorsal vessel originates in segm. xii. The nephridia have a large anteseptal portion, nearly as large as the postseptal; the duct undergoes several windings in the anteseptal portion; the organ is somewhat constricted at the septum; and the postseptal portion is elongated, the duct being continued from the hinder end.

The testes were in an early stage, of large size, taking up a very large part of segm. xi.; scarcely any sperm-morulae had formed, the testes were lobed, but not "divided." The funnels were very small, and twice as long as broad; but it is more than likely that these proportions would not be maintained throughout the further development of the organ. There was a small, ovoid, and well-defined penial body.

The ovaries were lobed in the same manner as the testes. The spermathecal ampulla was short, subspherical, and the duct cylindrical, entirely destitute of surrounding gland-cells. There were no copulatory glands.

The numbers of the setæ (2 per bundle throughout the body), the large anteseptal part of the nephridia, and the presence of a lumbricilline penial bulb constitute a group of characters which, along with the small size of the worms, may permit of recognition in the future; but I disapprove of the practice of giving names to incompletely described or immature material.

Genus MESENCHYTRÆUS Eisen.

MESENCHYTRÆUS sp.

Spitsbergen; among plants of dry tundra, Cape Boheman in Icefjord in W. Spitsbergen; 12.vii.1921. A single specimen.

Spitsbergen; among mosses on the bank of a fresh-water pond, more or less under water, Bruce City; end of July and beginning of August 1921. Two specimens.

Like the last, the present specimens are too immature to name.

Length 7-10 mm.; maximum diameter .6-.8 mm. Segms. 46-54. Colour dark brown. The worms are solid-looking, like the young of earthworms. A large head-pore near the tip of the proboscis. Setæ lumbricine in shape, stout and relatively short, with sigmoid curve; in the ventral bundles 4, 5, or 6 throughout the body; in the lateral 2 or 3 throughout, or sometimes behind the clitellum 4 or 5, and occasionally, in front of the clitellum, one only.

Cœlomic corpuscles rather small, 12-20 μ , granular, with deeply staining granules or network, and a small nucleus visible only with difficulty. No salivary glands; postpharyngeal bulbs

present. Œsophagus dilates fairly suddenly in segm. vii. Very numerous parasitic Ciliates in œsophagus; parasites also in œsophageal wall; a cyst outside, in the cœlom. Much of the alimentary epithelium is degenerating or has been shed. Dorsal vessel originates in xiv.; the blood stains with eosin. Nephridia of the type found in the genus; the duct goes backwards at first, then forwards, ending finally a very little way behind the inter-segmental groove, indeed almost in it.

Clitellum only slightly marked, extending over xii. and xiii. with the greater part of xi. also. Testes lobed, but not "divided." Sperm-sac present, extending into xiii. Funnel as yet merely a plate of cells on the septum; vas deferens only as a solid cord of cells, cylindrical and somewhat wavy, from funnel to male aperture. Penial bulb as a number of loosely arranged cells around the terminal portion of the vas deferens. Ovisac extending back to xvii. Spermathecal ampulla not distinguishable; duct narrow, no gland-cells round its ending, cylindrical, of some length, coming to the surface in the tract of the lateral line cells.

The distinction of species of *Mesenchytræus* depends largely on the characters of the vas deferens and spermathecal ampulla—just those portions of the sexual apparatus which are most undeveloped in the present specimens.

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